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14. ABSTRACT  This project is to explore an innovative CAD strategy for improving early detection of breast cancer in screening mammograms by focusing on computerized analysis and detection of cancers missed by radiologists. The research in the second year is on (i) continuation of missed cancer analysis with a focus on density analysis and its effect on CAD detection; (ii) new CAD system design. The achievements include (1) A comprehensive analysis was taken on the effect of breast density on cancer detection. The accomplishments include breast dense tissue segmentation, correlation analysis of mammogram density features between missed and detected stages, statistical testing of density difference between normal and cancerous mammograms, baseline study of the effect of density on CAD detection performance using existing algorithm. (2) A new CAD system was designed based on the existing second-generation CAD algorithm and the missed cancer analysis. Due to the effective modification strategies taken in the new system, detection performance was improved for mammograms at both detected and missed stages. However, with the focus on missed cancer analysis and detection, a bigger improvement was obtained in detecting missed cases even though the general detection performance is still lower than that at detected stage.					
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## INTRODUCTION

This project is to explore an innovative CAD strategy for improving early detection of breast cancer in screening mammograms by focusing on computerized analysis and detection of cancers missed by radiologists. Due to the unpredictable difficulty in data collection in the first year of research, a revision of the Statement of Work was made and approved by DoD to focus on the important research items. A big progress was made in the second year research to catch up the schedule. The third year's research is the continuation of this effort with focus on the evaluation of new CAD strategy.

## BODY

**Objective 1:** to measure the stand-alone detection sensitivity/specificity of the new CAD system.

### **Accomplishments:**

A new CAD system was designed in the second year research based on our two generations of CAD algorithms for mass detection using digitized mammogram [1][2] and the analysis results of missed cancer in this project. The strategies taken in this new CAD system design include (a) multi-mode detection by breast density classification; (b) breast area partition and region based adaptive detection; (c) weighted classification using the distinguishing features identified in missed cancer analysis.

In order to evaluate the new CAD strategy, it is important to test the sensitivity/specificity and its early cancer detection performance of a radiologist who is assisted by the CAD system and compare it with the performance of single and double reading. For this purpose, large costly trials with several radiologists and a large number of normal cases are required to represent the screening situation. Due to the time and budget limit of this project, before starting such trials, it is important to measure the stand-alone performance of the new CAD system and compare it with existing CAD [1].

Figure 1 and 2 show a comparison of the FROC curves of overall detection performance by new and conventional CAD systems on mammograms at missed and detected cancer stages. More detailed comparisons of detection on mammograms with low (<25%) and high (>25%) density at missed and detected stages are shown in Figure 3-6. It is observed that the new CAD system provides a better detection performance at both missed and detected stages. However, because the new CAD is designed with focus on missed cancer, a bigger improvement is obtained for missed cancer detection. The improvements on low and high dense mammograms are comparable.

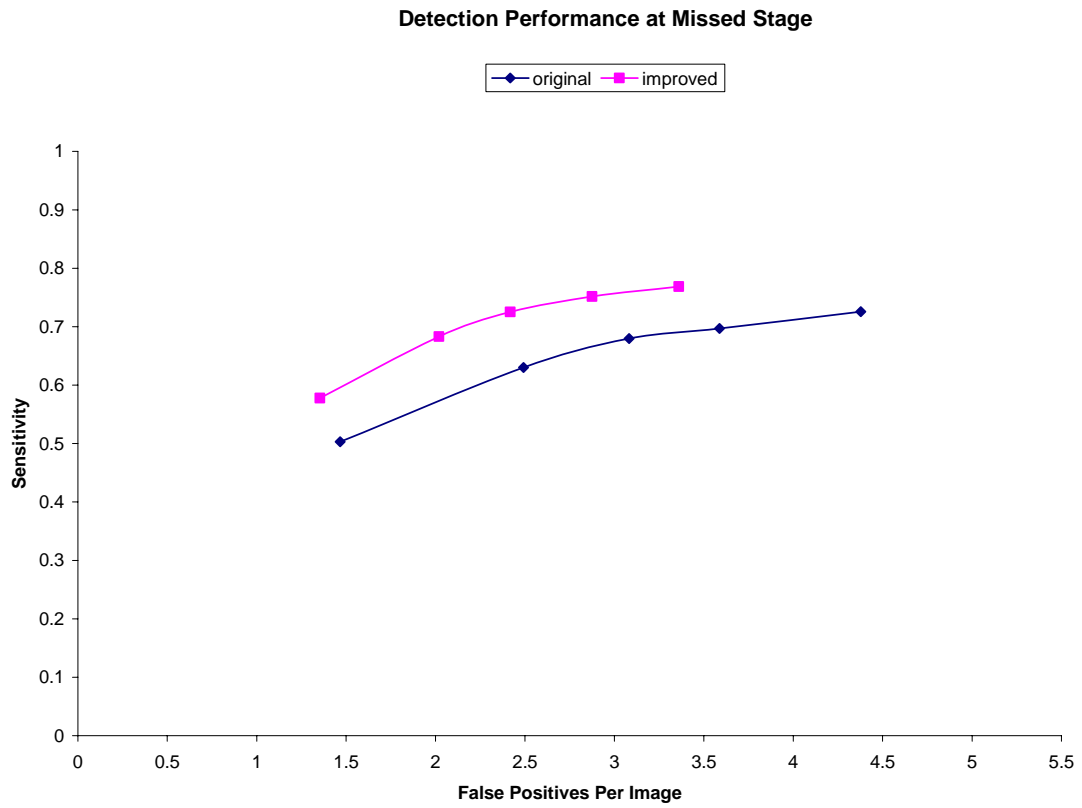


Figure 1. Improvement of CAD cancer detection on mammograms at screening missed stage.

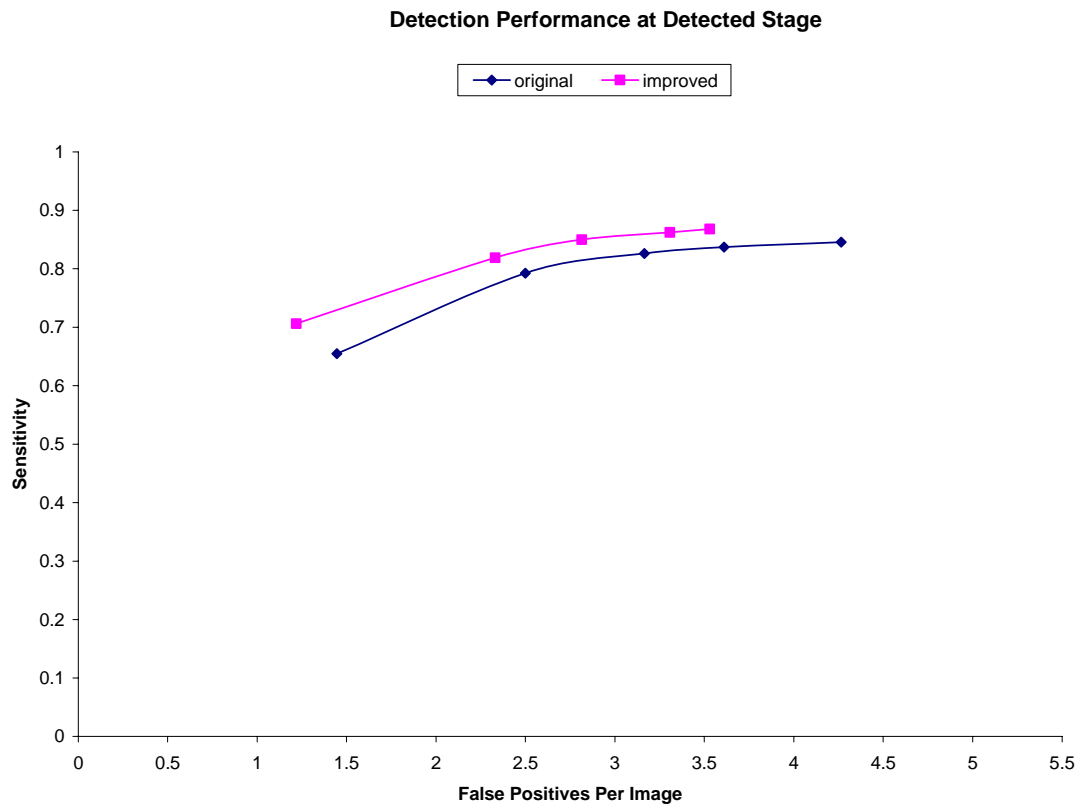


Figure 2. Improvement of CAD cancer detection on mammograms at screening detected stage.

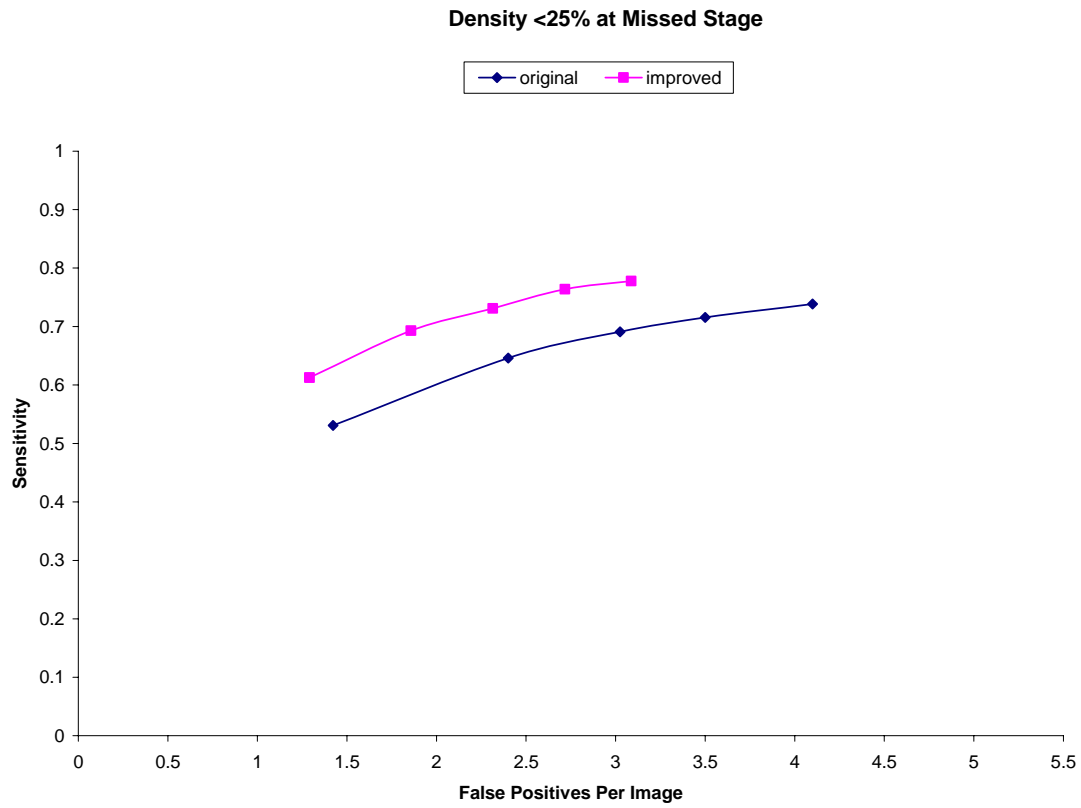


Figure 3. Improvement of CAD cancer detection on low dense mammograms at screening missed stage.

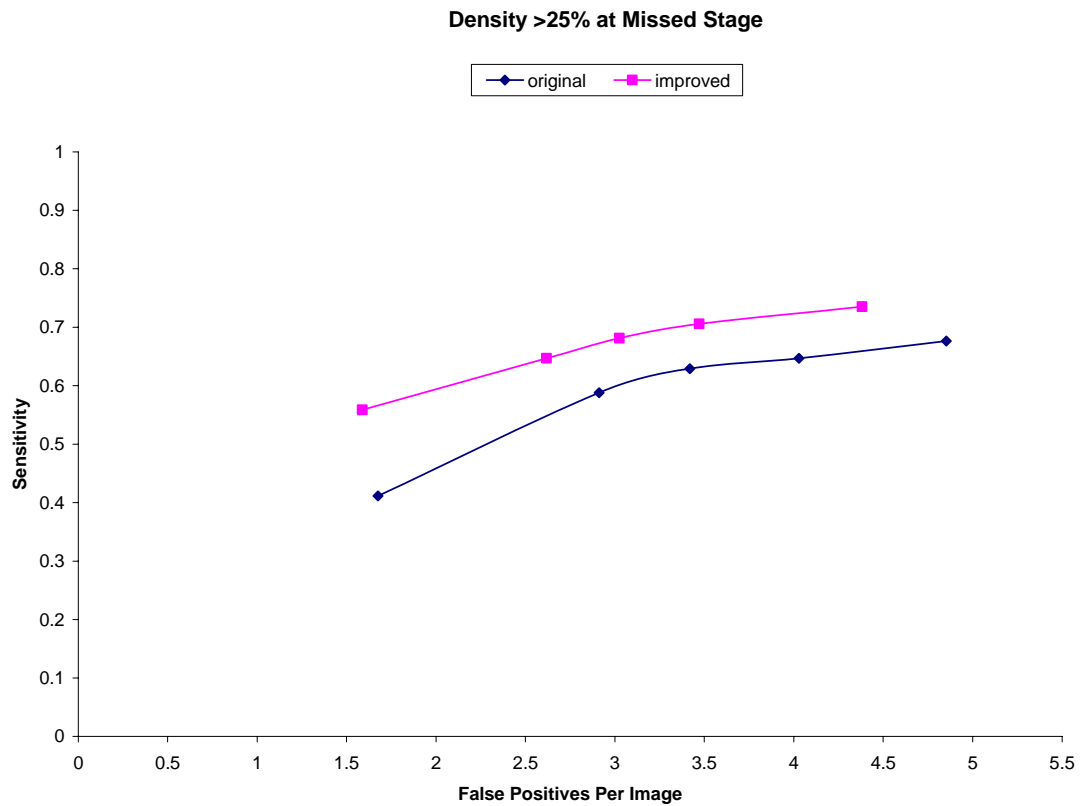


Figure 4. Improvement of CAD cancer detection on high dense mammograms at screening missed stage.

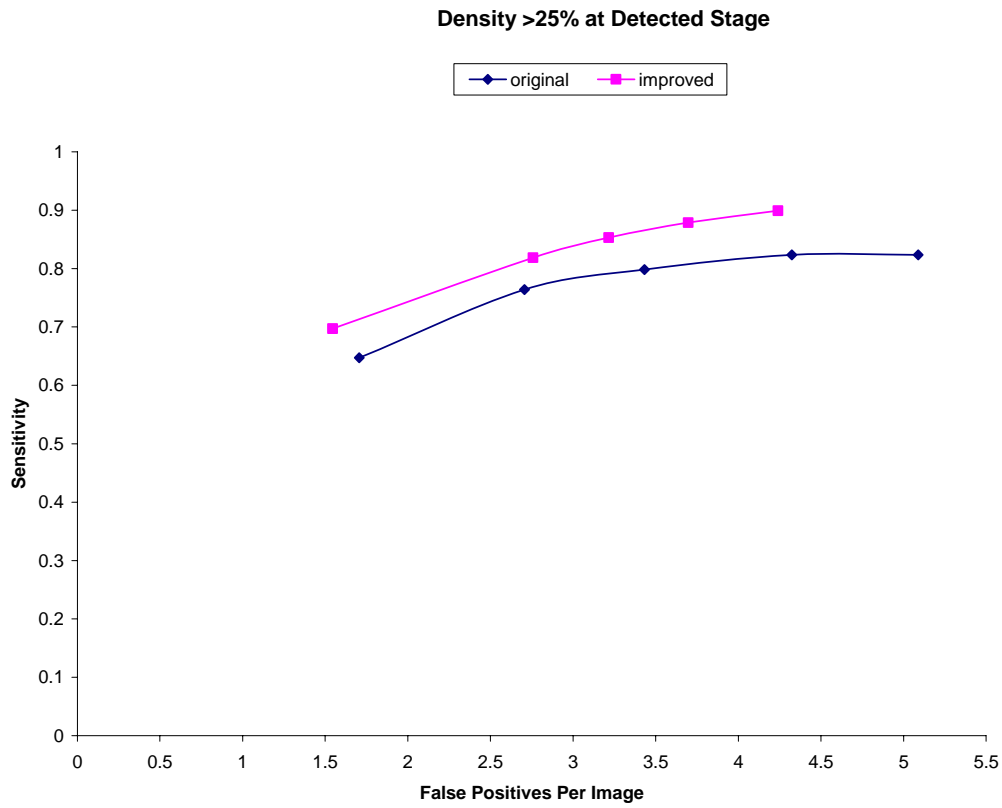


Figure 5. Improvement of CAD cancer detection on low dense mammograms at screening detected stage.

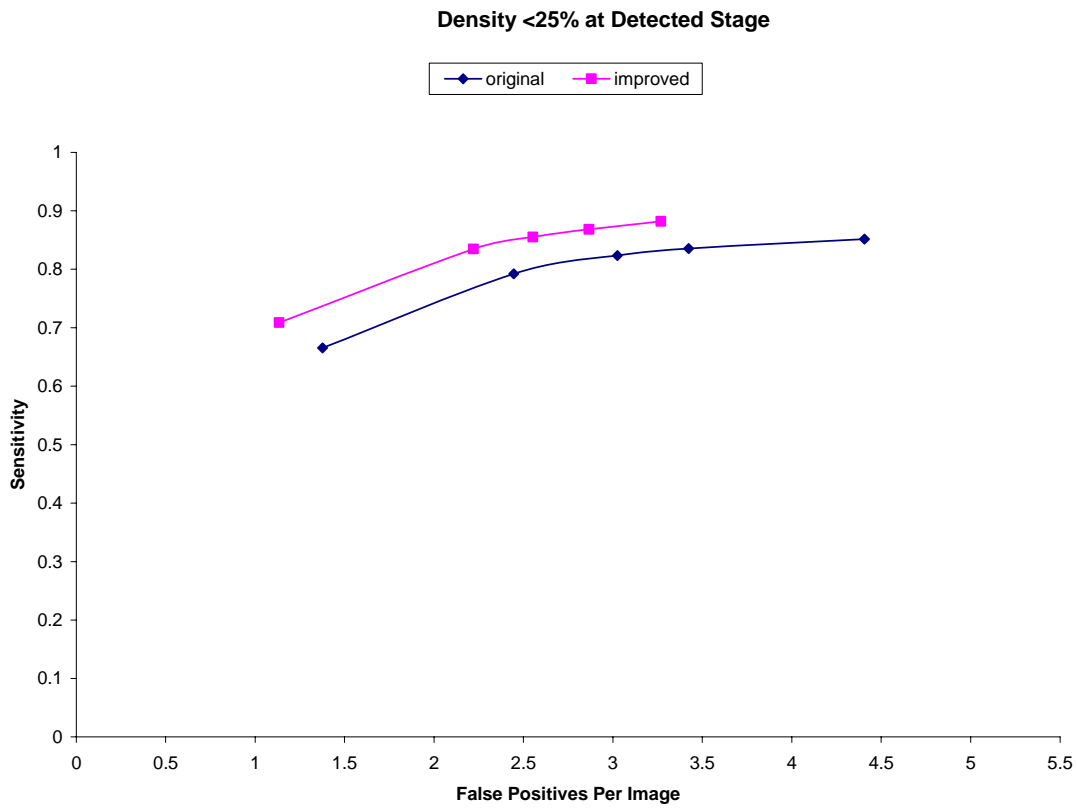


Figure 6. Improvement of CAD cancer detection on high dense mammograms at screening detected stage.

**Objective 2:** evaluation of early detection

**Accomplishments:**

An evaluation of early detection by using CAD system was taken. The earliness of detection is measured in terms of the number of months that the cancer is detected by CAD before it is detected by radiologist without assistance of CAD system. Here it is assumed that all true positive detections were accepted by radiologist and there were no negative effects of CAD false positives on decision making in diagnosis.

Figure 7 and 8 present the number of months of early detection at different false positive rates with existing and new CAD systems respectively. It is observed that the cancer could be detected earlier with less false positive signals by using the new CAD strategy.

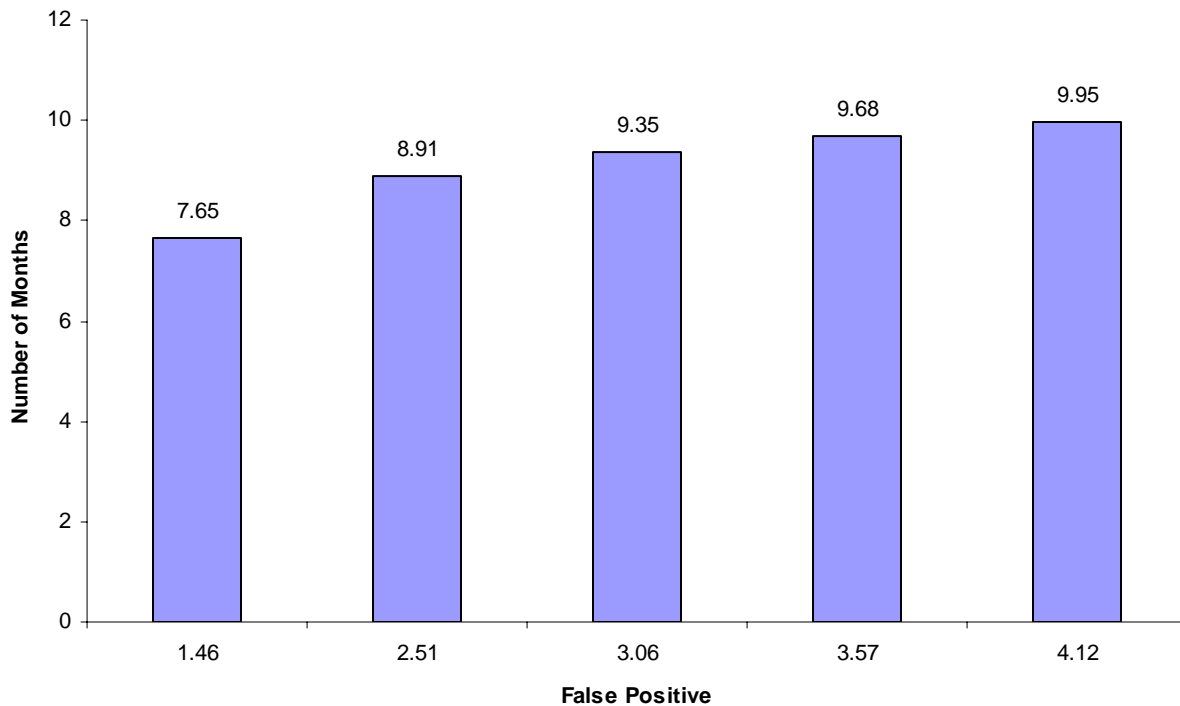


Figure 7. Early detection of cancers with existing CAD system



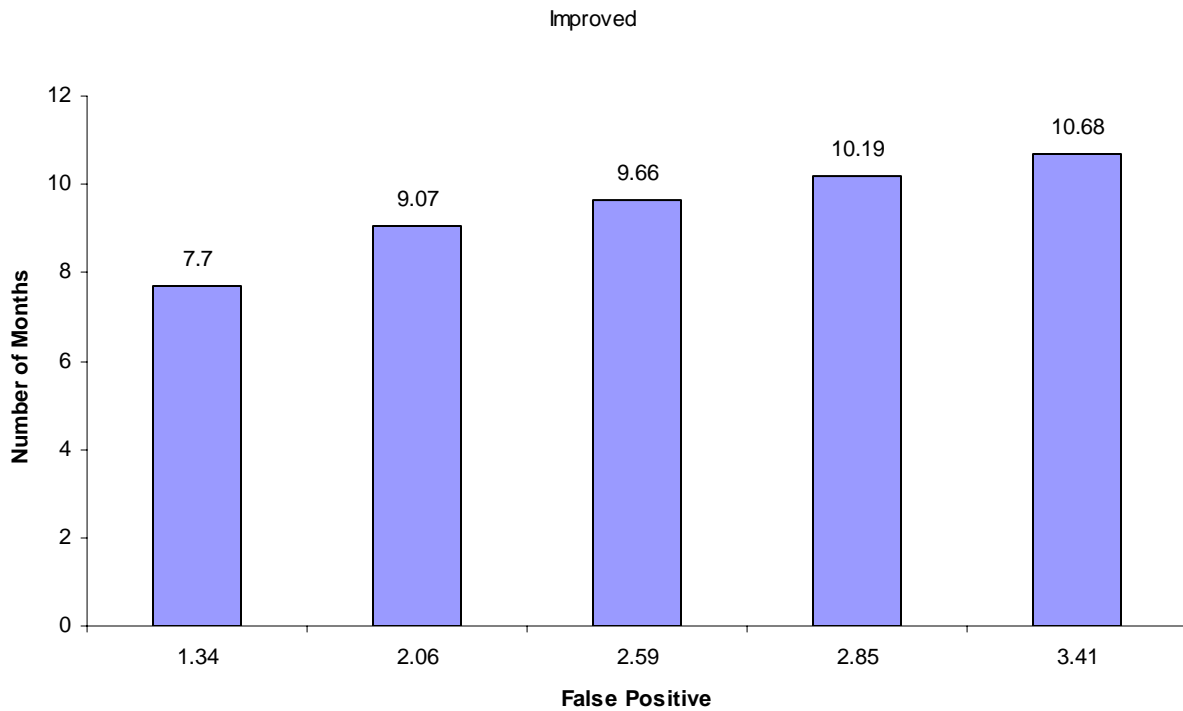


Figure 8. Early detection of cancers with new CAD system

## KEY RESEARCH ACCOMPLISHMENTS

1. An evaluation was taken to measure the stand-alone detection sensitivity/specificity of the new CAD system. Comparisons of overall detection performance and the detection on mammograms with low (<25%) and high (>25%) density at missed and detected stages were performed. It is observed that, due to the effective modification strategies taken in the new system, detection performance was improved for mammograms at both detected and missed stages. Because the new CAD system is designed with the focus on missed cancer analysis and detection, a bigger improvement was obtained in detecting missed cases even though the general detection performance is still lower than that at detected stage. The improvements on low and high dense mammograms are comparable.
2. An evaluation of early detection by using CAD system was taken. It is observed that the cancer could be detected earlier with less false positive signals by using the new CAD strategy.

## REPORTABLE OUTCOMES

### 1. Journal paper

(a) Lihua Li, Zuobao Wu, Zhao Chen, Angela Salem, Maria Kallergi, Claudia G. Berman  
 “Computerized Analysis of Tissue Density Effect on Missed Cancer Detection in Digital Mammography,” Computerized Medical Imaging and Graphics, 2006. (accepted for publication)

## **CONCLUSIONS**

This project is to explore an innovative CAD strategy for improving early detection of breast cancer in screening mammograms by focusing on computerized analysis and detection of cancers missed by radiologists. The research in this third year is (i) to measure the stand-alone detection sensitivity/specificity of the new CAD system, (ii) to evaluate the improvement of cancer early detection by using new CAD system.

## **REFERENCES**

- [1] L. Li, R.A. Clark, J. A. Thomas "Computer-aided diagnosis of masses in full-field digital mammography," Academic Radiology, 2002; 9.
- [2] L. Li, Yang Zheng, Lei Zhang, R.A. Clark, "False-positive reduction in CAD mass detection using a competitive classification strategy," Medical Physics, 28(2), Feb. 2001.